FAIRCHILD SEMICONDUCTOR®

June 2011

FAN7314A — LCD Backlight Inverter Drive IC

Features

- High-Efficiency Single-Stage Power Conversion
- Wide Input Voltage Range: 6V to 25.5V
- Backlight Lamp Ballast and Soft Dimming
- Minimal Required External Components
- Precision Voltage Reference Trimmed to 2%
- ZVS Half-Bridge Topology
- Soft-Start
- PWM Control at Fixed Frequency
- Analog and Burst Dimming Function
- Programmable Striking Frequency
- Open-Lamp Protection
- Open-Lamp Regulation
- Thermal Shutdown
- 20-Pin SOIC

Applications

- LCD TV
- LCD Monitor

Description

The FAN7314A provides all the control functions for a series parallel resonant converter as well as a pulse width modulation (PWM) controller to develop a supply voltage. Typical operating frequency range is between 30kHz and 250kHz, depending on the CCFL and the transformer's characteristics.

The FAN7314A is available in a 20-SOIC package.

20-SOIC

Ordering Information

Part Number	Package	Operating Temperature	Packing Method
FAN7314AM	20-SOIC	-25 to +85°C	RAIL
FAN7314AMX	20-SOIC	-25 to +85°C	TAPE & REEL

Important Note:

For complete performance specifications, please contact one of the following:

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Block Diagram

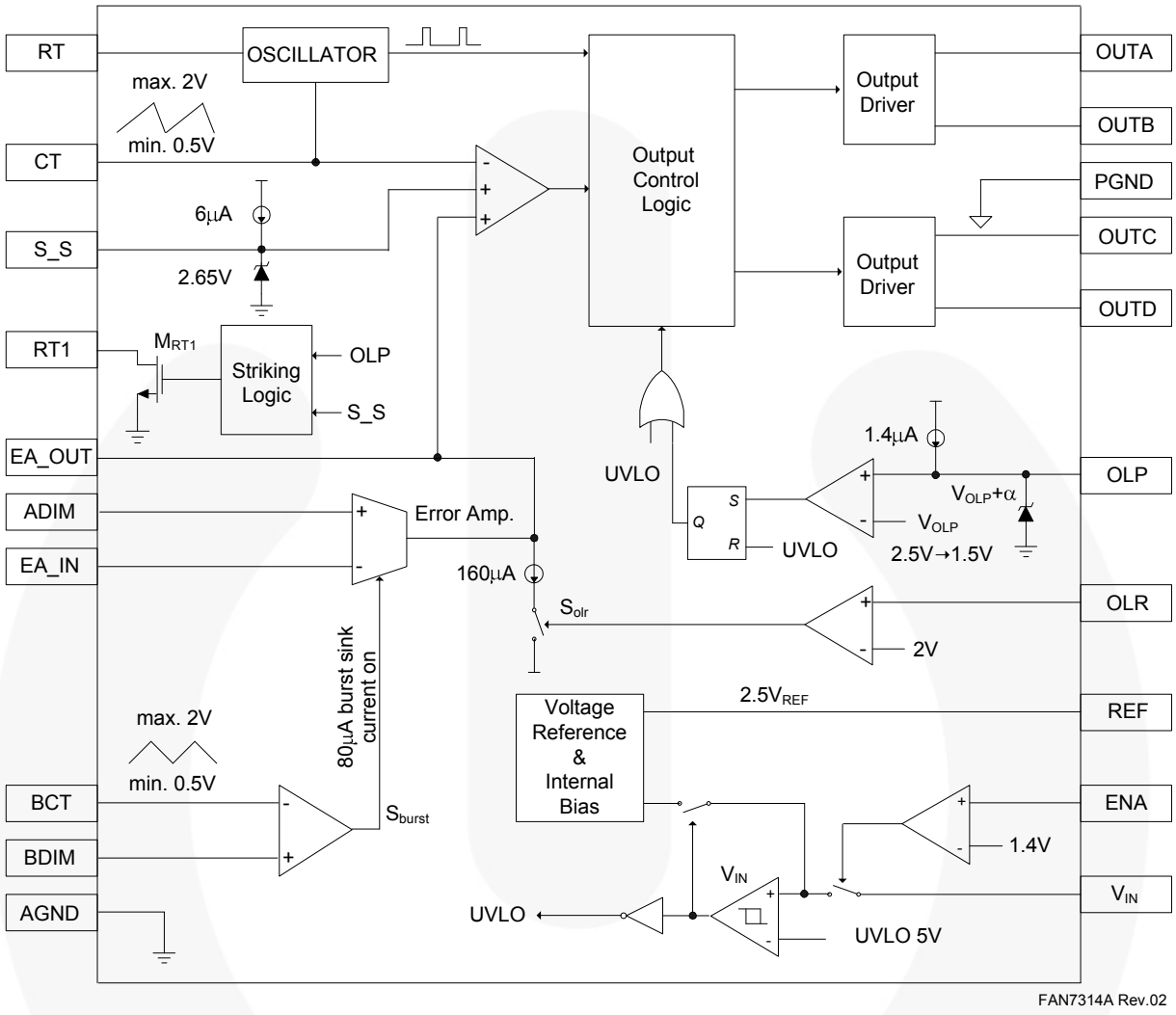
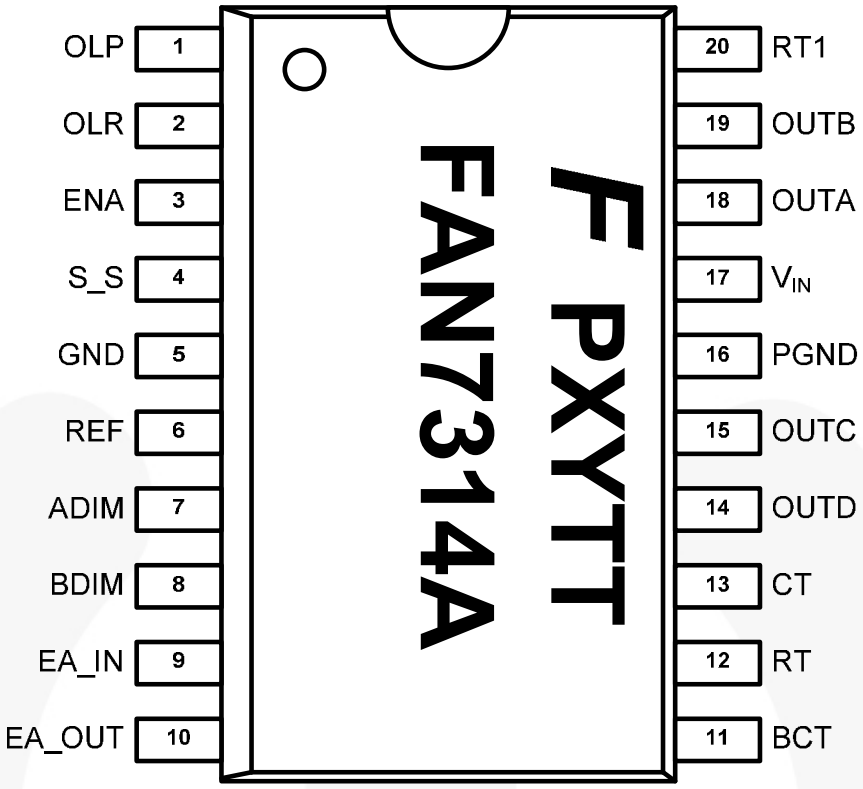


Figure 1. Internal Block Diagram

Pin Configuration



F : Fairchild logo
P : Assembly site code
XY : Year & weekly code
TT : Die run code
FAN7314A : Device name

Figure 2. Package Diagram

Pin Definitions

Pin #	Name	Description
1	OLP	**Open-Lamp Protection**. Typically, a capacitor is connected to this pin from the ground. The capacitor is charged by the 1.4μA internal current source and when its voltage is more than 2.5V the IC enters into the shutdown mode.
2	OLR	**Open-Lamp Regulation**. If the voltage of the OLR pin is more than 2V, the voltage of the EA_OUT pin voltage will be discharged by the 160μA internal current source.
3	ENA	**Enable**. Turns on/off the IC.
4	S_S	**Soft-Start**. Typically, a capacitor is connected to this pin from the ground. The capacitor is charged by the 6μA internal current source. Soft start operation is working while the S_S pin voltage is less than the EA_OUT pin voltage.
5	GND	**Ground**. Control block.
6	REF	**Reference**. 2.5V reference output.
7	ADIM	**Analog Dimming**. This pin is the input for positive polarity. The lamp current decreases with decreasing this pin voltage.
8	BDIM	**Burst Dimming**. This pin is the input for negative polarity. The voltage range of 0.5 to 2V at this pin controls burst mode duty cycle from 0% to 100%.
9	EA_IN	**Error Amplifier Inverting Input**. This pin voltage is regulated at ADIM voltage.
10	EA_OUT	**Error Amplifier Output**. Typically, a compensation capacitor is connected to this pin from the ground.
11	BCT	**Burst Timing Capacitor**. This pin is for programming the frequency of the burst dimming. Typically, a capacitor is connected to this pin from the ground. The BCT frequency increases with decreasing its capacitance.
12	RT	**Timing resistor**. This pin is for programming the switching frequency. Typically, a resistor is connected to this pin from the ground. The switching frequency increases with decreasing its resistance.
13	CT	**Timing Capacitor**. This pin is for programming the switching frequency. Typically, a capacitor is connected to this pin from the ground. The switching frequency increases with decreasing its capacitance.
14	OUTD	**NMOS Gate-Drive Output**.
15	OUTC	**PMOS Gate-Drive Output**.
16	PGND	**Power Ground**.
17	VIN	**Supply Voltage**.
18	OUTA	**PMOS Gate-Drive Output**.
19	OUTB	**NMOS Gate-Drive Output**.
20	RT1	**Striking Timing Resistor**. Typically, a resistor is connected to this pin from the RT pin. The striking frequency increases with decreasing its resistance.

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Min.	Max.	Unit
V_{IN}	IC Supply Voltage	6	25.5	V
T_A	Operating Temperature Range	-25	+85	°C
T_J	Operating Junction Temperature		+150	°C
T_{STG}	Storage Temperature Range	-65	+150	°C
θ_{JA}	Thermal Resistance Junction-Air[1,2]		90	°C/W
P_D	Power Dissipation		1.4	W

Notes:
1. Thermal resistance test board. Size: 76.2mm x 114.3mm x 1.6mm (1S0P); JEDEC standard: JESD51-2, JESD51-3.
2. Assume no ambient airflow.

Pin Breakdown Voltage

Pin #	Name	Value	Unit	Pin #	Name	Value	Unit
1	OLP	7	V	11	BCT	7	V
2	OLR	7		12	RT	7	
3	ENA	7		13	CT	7	
4	S_S	7		14	OUTD	10.5	
5	GND	7		15	OUTC	25.5	
6	REF	7		16	PGND	7	
7	ADIM	7		17	VIN	25.5	
8	BDIM	7		18	OUTA	25.5	
9	EA_IN	7		19	OUTB	10.5	
10	EA_OUT	7		20	RT1	7	

Electrical Characteristics

For typical values, T_A = 25°C, V_{IN} = 12V, and -25°C ≤ T_A ≤ 85°C, unless otherwise specified. Specifications to -25°C ~ 85°C are guaranteed by design based on final characterization results.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
REFERENCE SECTION (Recommended X7R Capacitor)						
ΔV_{ref}	Line Regulation	5 ≤ V_{IN} ≤ 25.5V		2	25	mV
V_{25}	2.5V Regulation Voltage		2.45	2.5	2.55	V
OSCILLATOR SECTION (MAIN)						
f_{OSC}	Oscillation Frequency	T_A=25°C, CT=270pF, RT=18kΩ	110.4	115.0	119.6	kHz
		CT=270pF, RT=18kΩ	108	115	122	
V_{cth}	CT High Voltage			2.0		V
V_{ctl}	CT Low Voltage			0.5		V
OSCILLATOR SECTION (BURST)						
f_{oscb}	Oscillation Frequency	T_A=25°C, C_{tb}=10nF, RT=18kΩ	195	220	246	Hz
		C_{tb}=10nF, RT=18kΩ	191	220	249	
V_{bcth}	BCT High Voltage			2		V
V_{bctl}	BCT Low Voltage			0.5		V
ERROR AMPLIFIER SECTION						
G_m	Error Amplifier Trans-conductance	EA_OUT=1V, ADIM=1V	100	360	600	umho
A_v	Error Amplifier Open-loop Gain(3)			50		dB
V_{eh}	EA_OUT Clamping Voltage		2.3	2.7	3.0	V
I_{sin}	Output Sink Current	ADIM=1V, EA_IN=2V	35	70	105	µA
I_{sur}	Output Source Current	ADIM=1V, EA_IN=0V	-154	-110	-66	µA
I_{olr}	EA_OUT Sink Current on OLR	OLR>2.5V	-210	-160	-110	µA
I_{burst}	EA_OUT Sink Current on Burst Dimming		-100	-80	-60	µA
SOFT-START SECTION						
I_{SS}	Soft-Start Current	S_S=1V	4	6	8	µA
V_{ssh}	Soft-Start Clamping Voltage		2.3	2.65	3.00	V
PROTECTION SECTION						
V_{olp0}	Open-Lamp Protection Voltage 0	Start at open lamp	2.2	2.5	2.8	V
V_{olp1}	Open-Lamp Protection Voltage 1	Normal -> open lamp	1.3	1.5	1.7	V
V_{olr}	Open-Lamp Regulation Voltage		1.75	2.00	2.25	V
I_{olp}	Open-Lamp Protection Charging Current		0.7	1.4	2.1	µA

Note:

3. These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (Continued)

For typical values, T_A = 25°C, V_{IN} = 15V, and -25°C ≤ T_A ≤ 85°C, unless otherwise specified. Specifications to -25°C ~ 85°C are guaranteed by design based on final characterization results.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
UNDER VOLTAGE LOCK OUT SECTION						
V_{th}	Start Threshold Voltage				5	V
I_{st}	Start-up Current	$V_{IN}=V_{th}$-0.2		130	180	µA
I_{op}	Operating Supply Current	V_{IN}=12V		1.5	4.0	mA
I_{sb}	Stand-by Current	V_{IN}=12V		200	370	µA
ON/OFF SECTION						
V_{on}	On State Input Voltage		2		5	V
V_{off}	Off Stage Input Voltage				0.7	V
OUTPUT SECTION						
V_{pdhv}	PMOS Gate Drive High Voltage	V_{IN}=12V		V_{IN}		V
V_{phlv}	PMOS Gate Drive Low Voltage	V_{IN}=12V	V_{IN}-10.5	V_{IN}-8.5	V_{IN}-6.5	V
V_{ndhv}	NMOS Gate Drive High Voltage	V_{IN}=12V	6.5	8.5	10.5	V
V_{ndlv}	NMOS Gate Drive Low Voltage	V_{IN}=12V		0		V
V_{puv}	PMOS Gate Voltage with UVLO Activated	$V_{IN}=V_{th}$-0.2	V_{IN}-0.3			V
V_{nuv}	NMOS Gate Voltage with UVLO Activated	$V_{IN}=V_{th}$-0.2			0.3	V
t_r	Rising Time[4]	V_{IN}=12V, C_{load}=2nF		200	500	ns
t_f	Falling Time[4]	V_{IN}=12V, C_{load}=2nF		200	500	ns
MAXIMUM / MINIMUM OVERLAP						
	Min. Overlap between diagonal switches[4]	f_{osc} = 100kHz		0		%
	Max. Overlap between diagonal switches[4]	f_{osc} = 100kHz		100		%
DELAY TIME						
	PDR_A/NDR_B[4]	RT=18kΩ		450		ns
	PDR_C/NDR_D[4]	RT=18kΩ		450		ns

Note:
4. These parameters, although guaranteed, are not 100% tested in production.

Functional Description

UVLO: The under-voltage lockout (UVLO) circuit guarantees stable operation of the IC's control circuit by stopping and starting it as a function of the VIN value. The UVLO circuit turns on the control circuit when VIN exceeds 5V. When VIN is lower than 5V, the IC's standby current is less than 200μA.

ENA: Applying voltage higher than 2V to the ENA pin enables the operation of the IC. Applying voltage lower than 0.7V to the ENA pin disables the operation of the inverter.

Soft-start: The soft-start function requires that the S_S pin is connected through a capacitor to GND. A soft-start circuit ensures a gradual increase in the input and output power. The capacitor connected to the S_S pin determines the rate at which the duty ratio rises. It is charged by a 6μA current source.

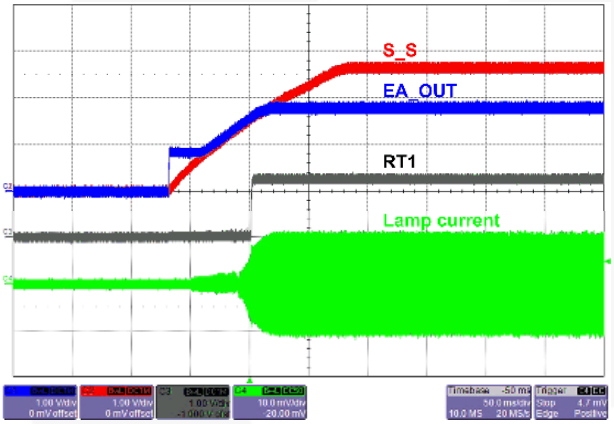


Figure 3. Soft-start during Initial Operation

Main Oscillator: The timing capacitors (CTs) are charged by the reference current source, which is formed by the timing resistor (RT). The timing resistor's voltage is regulated at 1.25V. The sawtooth waveform charges up to 2V. Once this voltage is reached, the capacitors begin discharging down to 0.5V. Next, the timing capacitors start charging again and a new switching cycle begins. The main frequency can be programmed by adjusting the RT and CT values. The main frequency can be calculated as shown below.

$$f_{OSC} = \frac{19}{32 \cdot RT \cdot CT} \quad (1)$$

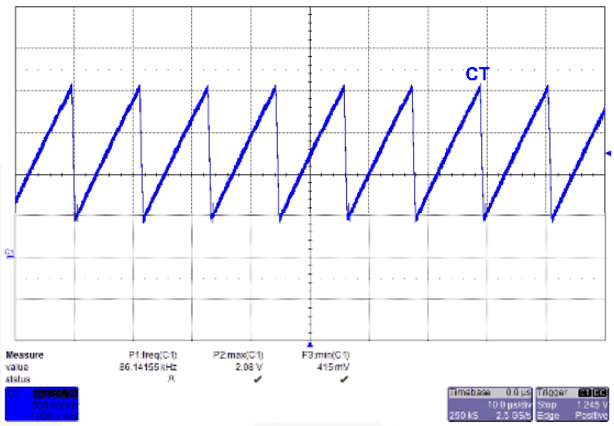


Figure 4. Main Oscillator Waveform

Burst Oscillator and Burst Dimming: The timing capacitors (BCTs) are charged by the reference current source, which is formed by the timing resistor (RT). The timing resistor's voltage is regulated at 1.25V. The sawtooth waveform charges up to 2V. Once this voltage is reached, the capacitors begin discharging down to 0.5V. Next the timing capacitors start charging again and a new switching cycle begins. The burst dimming frequency can be programmed by adjusting the RT and BCT values. The burst dimming frequency can be calculated as shown below.

$$f_{OSCB} = \frac{3.75}{96 \cdot RT \cdot CT} \quad (2)$$

To avoid visible flicker, the burst dimming frequency should be greater than 120Hz.

By comparing the input of BDIM pin with the 0.5~2V triangular wave of the burst oscillator the PWM pulses for burst dimming. The PWM pulse controls EA_OUT's voltage by summing 85μA into the EA_IN pin.

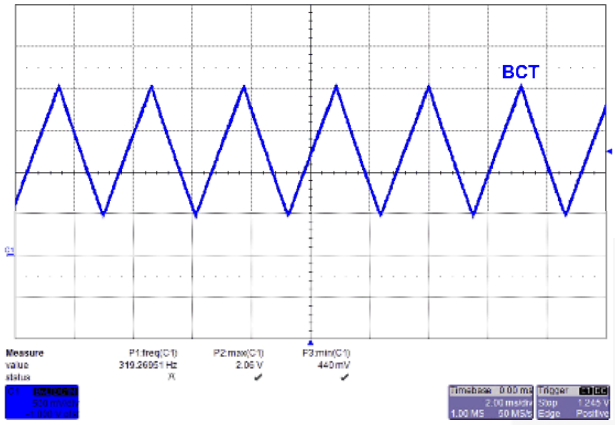


Figure 5. Burst Oscillator Waveform

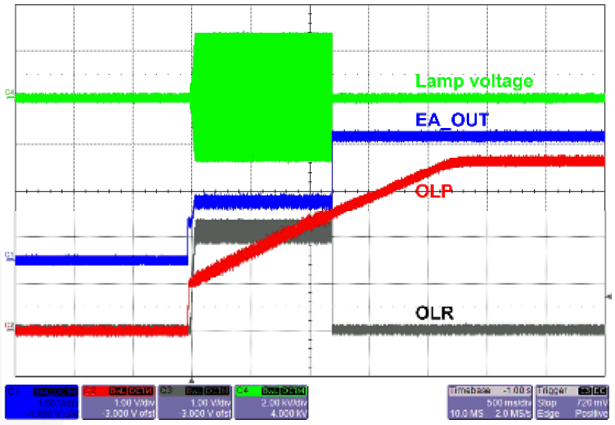


Figure 7. OLR Voltage during Striking Mode

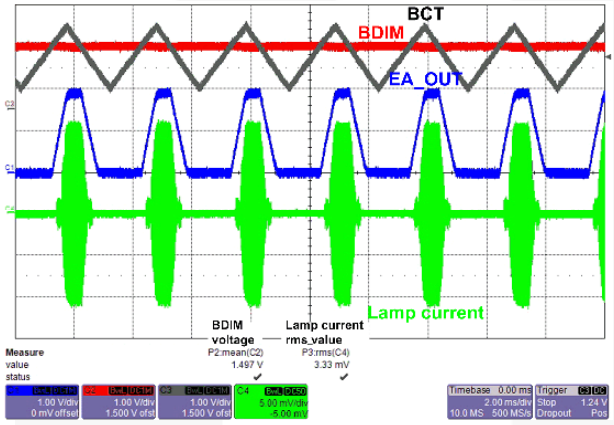


Figure 6. Burst Dimming

Output Drives: The four output drives are designed so that switches A and B, C and D never turn on simultaneously. The OUTA-OUTB pair is intended to drive one half-bridge in the external power stage. The OUTC-OUTD pair drives the other half-bridge.

Open-Lamp Regulation and Open-Lamp Protection: It is necessary to suspend power stage operation if an open lamp occurs because the power stage has high gain. When a voltage higher than 2V is applied to the OLR pin, the part enters regulation mode and controls the EA_OUT voltage. This limits the lamp voltage by summing 105μA into the feedback node. At the same time, the OLP capacitor, connected to the OLP pin, is charged by the 1.4μA internal current source. Once it reaches 2.5V, the IC shuts down and all output is high.

Timing Diagram

The FAN7314A uses the half-bridge to drive CCFL.

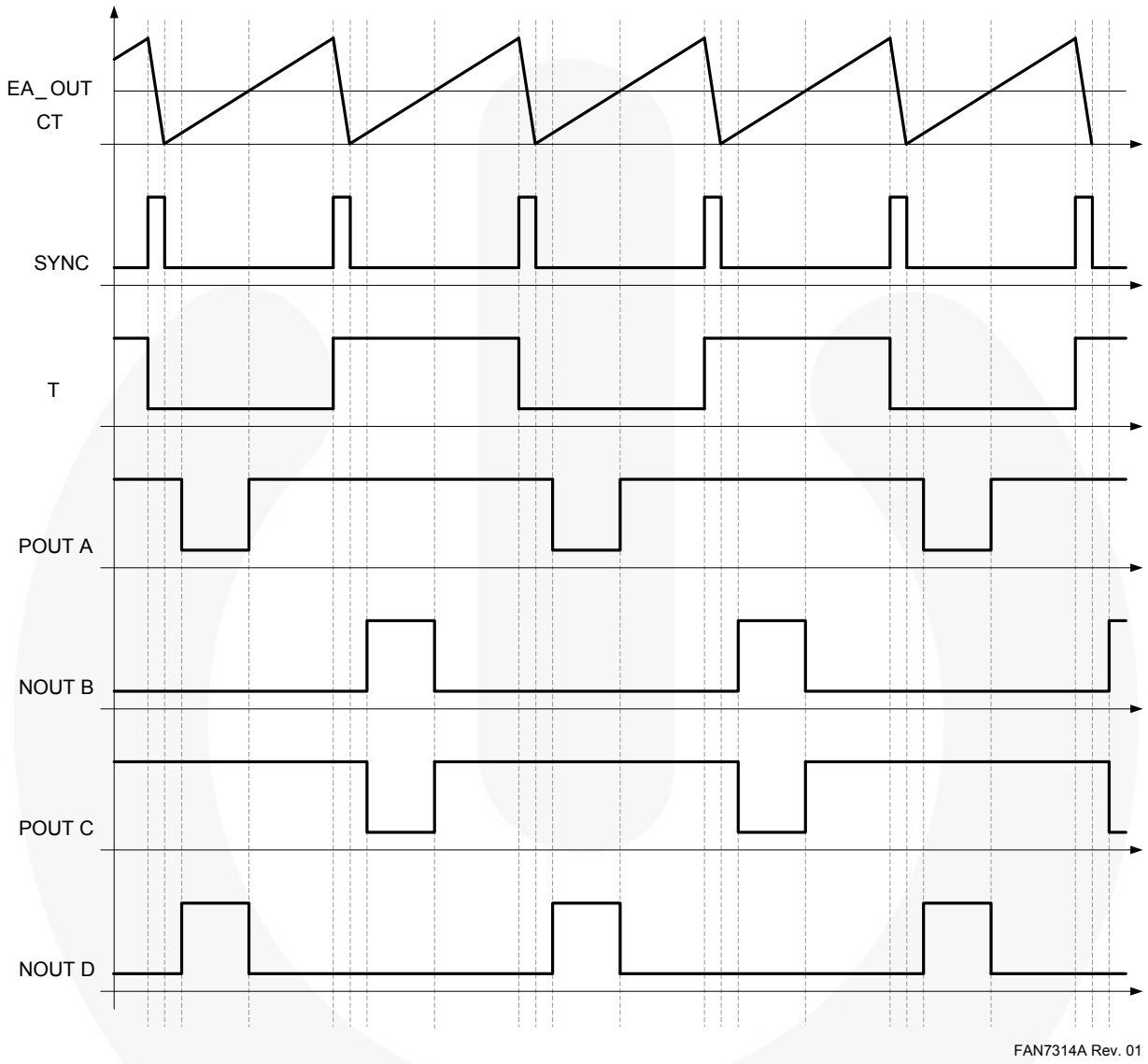


Figure 8. MOSFET Gate Drive Signal

Typical Application Circuit (LCD Backlight Inverter)

Application	Device	Input Voltage Range	Number of lamps
22-Inch LCD Monitor	FAN7314A	22V±5%	4

1. Features

- High-Efficiency Single-Stage Power Conversion
- P-N Half-Bridge Topology
- Reduces Required External Components
- Enhanced System Reliability through Protection Functions

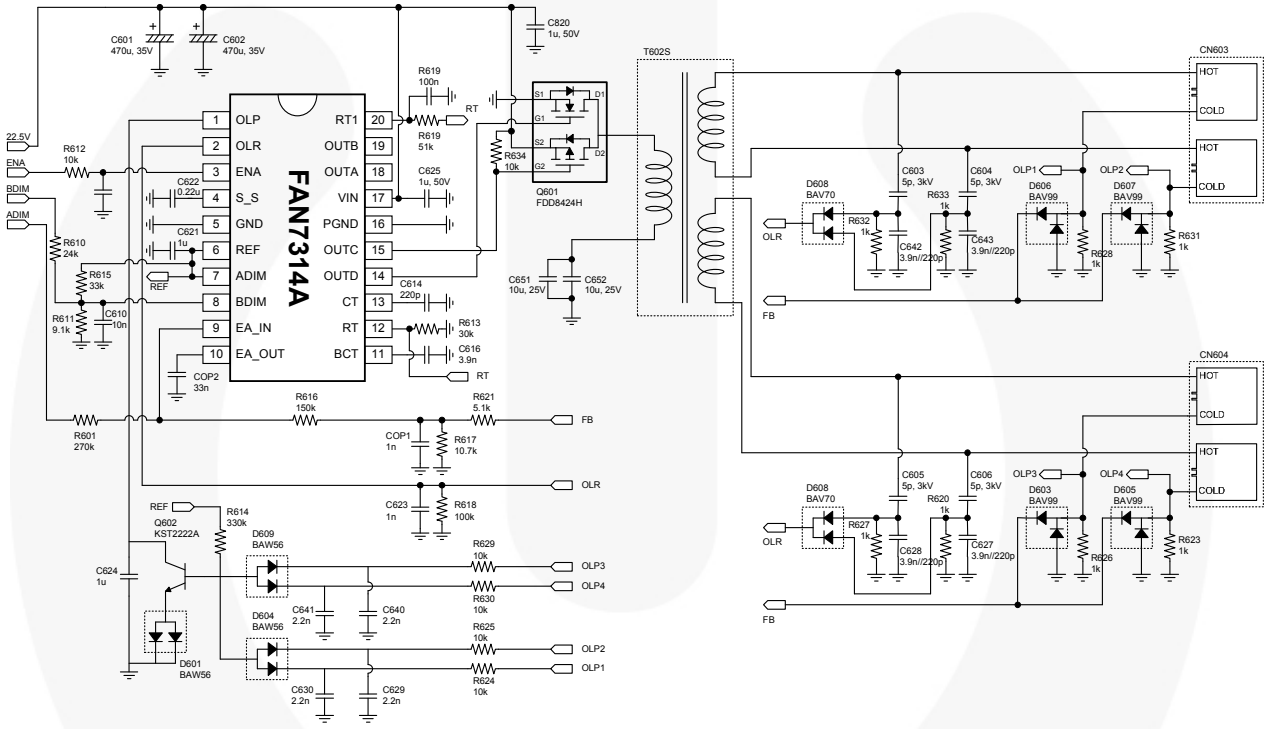


Figure 9. Typical Application Circuit

2. Transformer Specifications

- Supported by Clover Hitech (http://www.cloverhitech.com)
- PART NO : EEL-22W

Pin No.	Wire	Turns	Inductance	Leakage Inductance	Remarks
2 → 7	UTSC 0.1×12	19	83.0μH	16μH	1kHz, 1V
3 → 6					
1 → 8	1 UEW 0.04Ω	2300	1.4H	280mH	
4 → 5					

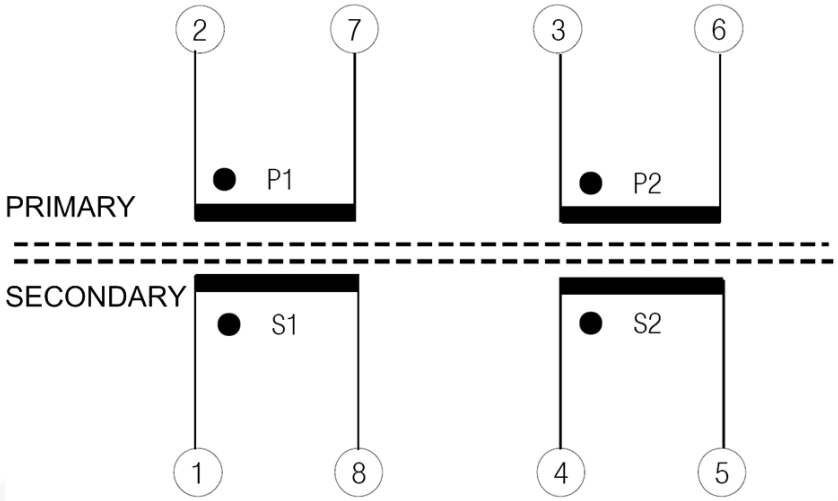


Figure 10. Schematic Diagram

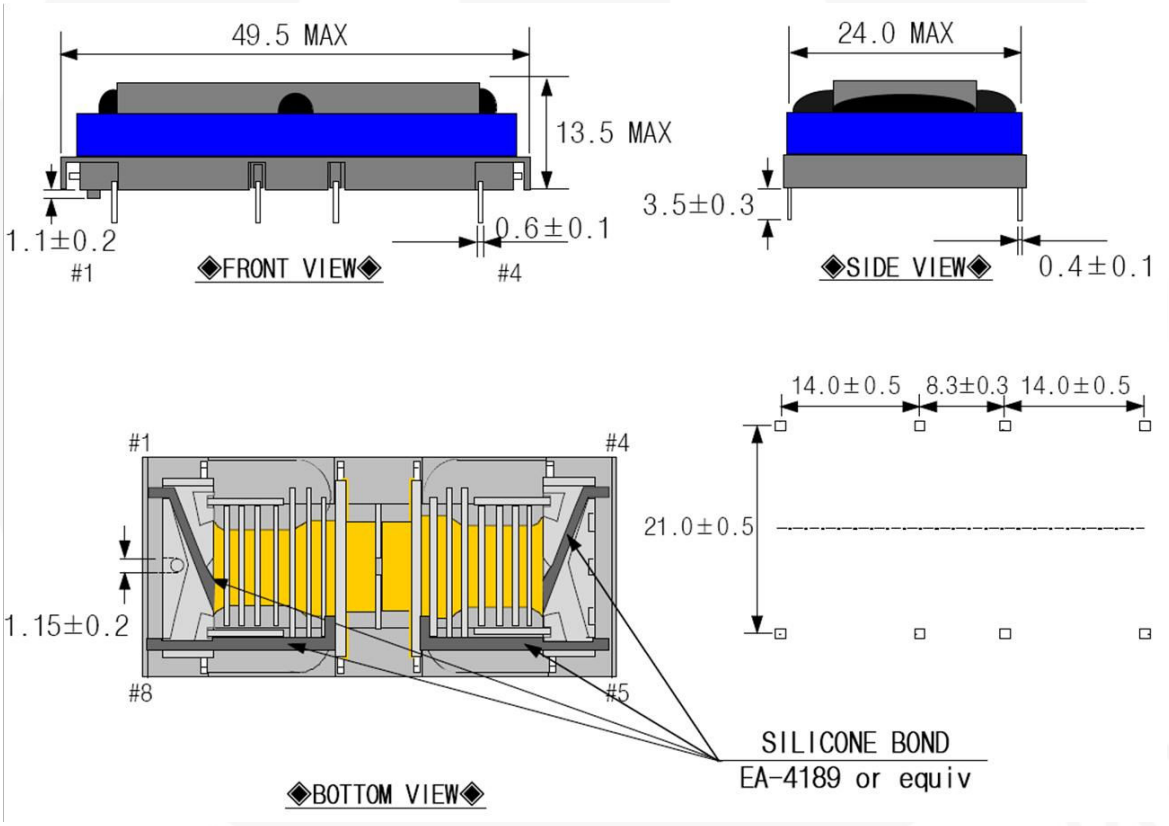


Figure 11. Dimensions

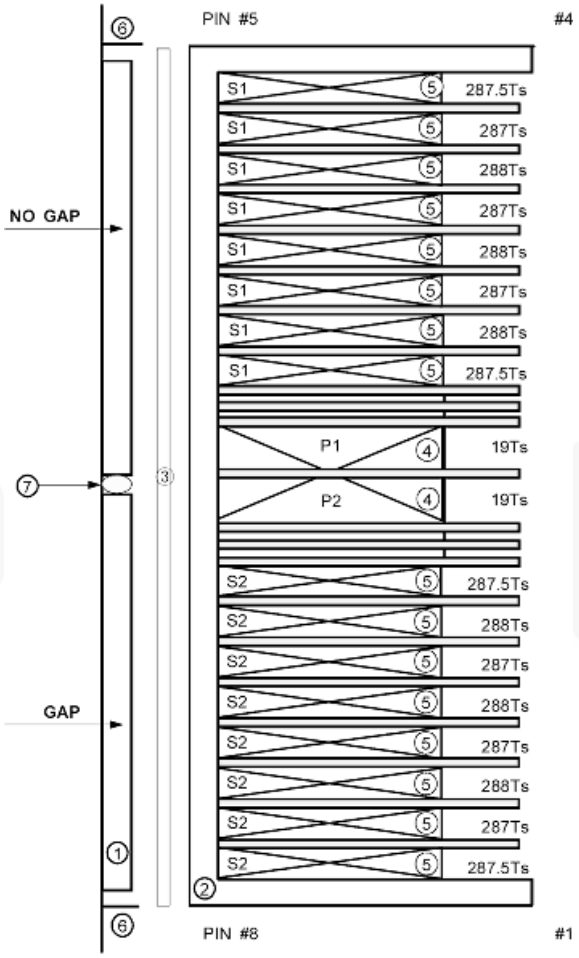


Figure 12. Section Diagram

Physical Dimensions

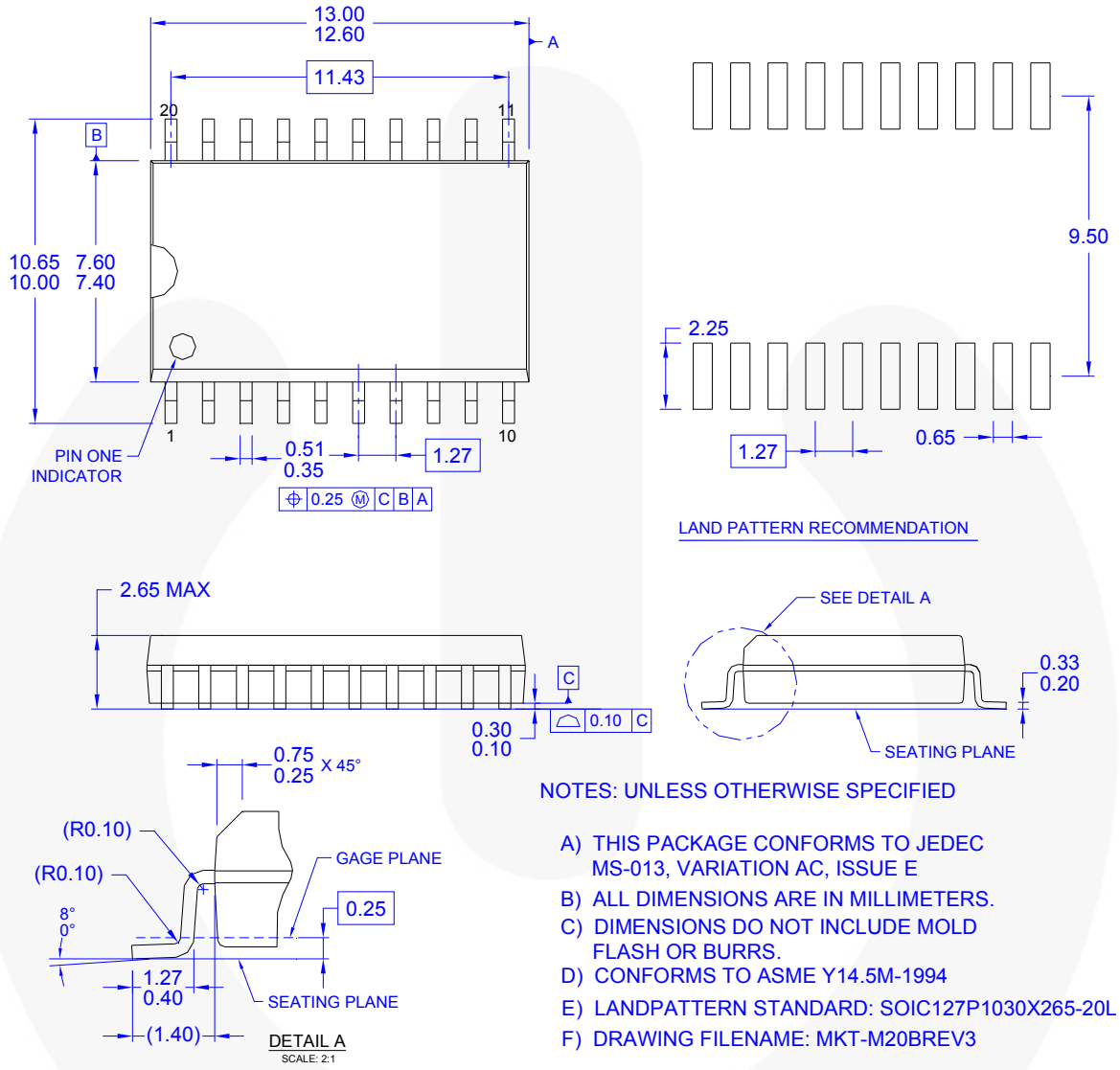


Figure 13. 20-SOIC Package

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